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ABSTRACT

This guide is designed to help teachers use various teacher-directed and student-centered strategies to increase students' involvement in and responsibility for their own learning, focusing on: "Introduction"; "Planning for Instruction" (e.g,. good instructional planning is aligned to course standards, students are actively engaged, teachers plan collaboratively, and administrators are supportive); "Striking a Balance"; "Teacher-Directed Instruction"; "Student-Centered Learning" (cooperative learning, project based learning, the Socratic method, independent research projects, reading and writing across the curriculum, content-specific strategies, and integrated learning); "Using Technology in the Classroom" (tips for using technology to engage student learning); and "Classroom Management" (e.g., establish concrete, explicit, and functional rules and procedures; monitor and reinforce the rules; anticipate possible interruptions or problems; and establish routines for transition periods). Suggestions are provided related to organization, speaking with students, listening to students, classroom misbehavior, instructional strategies, and getting students to work beyond normal limits. (SM)

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Instructional Strategies:

How Teachers Teach Matters

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Instructional Strategies:

How Teachers Teach Matters

Introduction

This guide is designed to help teachers use various teacher-directed and student-centered strategies to increase students' involvement in and responsibility for their own learning. In 12 years of data analysis, *High Schools That Work (HSTW)* has found that students learn more when they are engaged with challenging content through planned learning activities. Higher-level academic and technical courses are essential to raising student achievement, but if teachers don't adopt new teaching methods, many students will not succeed. Schools that show the greatest gains in student achievement not only enroll more students in higher-level courses but also adopt several other key requirements:

- Students must read several books each year outside of class and complete writing assignments at least weekly.
- Students must complete science projects, prepare written reports and make oral presentations.
- Students must use computers in completing assignments for academic and career/technical classes.
- Students must use knowledge and skills in solving real-world problems.
- Students must share with others what they've learned.
- Students must use graphing calculators in completing daily or weekly mathematics assignments.
- Students must work together frequently to complete challenging mathematics and science assignments.

Teachers and school leaders need to keep in mind what promotes learning:

1. good instructional planning;
2. a balanced use of student- and teacher-centered approaches;
3. well-planned, teacher-centered instruction;
4. various, proven, student-centered instructional strategies;
5. the use of technology to motivate, challenge and engage students; and
6. classroom conditions that promote learning.

Planning for instruction

Each day teachers make many decisions about instruction. They think on their feet and vary instruction to suit different situations. Flexibility is necessary for good teaching, but it does not take precedence over thoughtful planning. Planning is central to effective instruction; to do it well, a teacher needs a variety of tools and resources:

- data on student achievement;
- knowledge of curricular goals and objectives;
- knowledge of course standards;
- an understanding of methods for assessing student progress;
- a repertoire of effective instructional strategies; and
- good instructional materials.

Good instructional planning is aligned to course standards.

Good instructional planning begins with course standards that are aligned to state and/or national standards. These standards are content-specific and related to student behavior and thought. All teacher activities, student assignments, scoring guides and classroom assessments are planned to help students achieve these course standards.

Good instructional planning stresses high expectations.

Good instructional planning begins with high expectations for all middle grades and high school students. Lesson plans, units, projects and assignments become more than objectives and activities; they become instructional strategies to promote problem-solving, research, reflection and real-world applications. To motivate all students to

learn at higher levels, teachers must plan various instructional strategies that address students' different learning styles, backgrounds and interests.

Good instructional planning actively engages students.

Good instructional planning explores ways to engage students in using knowledge and skills to solve problems and to develop and explore hypotheses. Teachers do not forgo well-planned lectures for presenting information to students, but they do begin to see themselves less as keepers of knowledge and more as facilitators of learning. They create experiences that help students make sense of the knowledge and skills being studied. When students are responsible for their learning, teachers can invest more time in planning engaging assignments.

Good instructional planning involves teachers' working together.

Teachers need to work together so that students can see the connections in what they are asked to learn. Working in teams, teachers see the relationships among various content areas, develop means of supporting one another and produce scoring guides for quality student work. When academic and career/technical teachers align academic standards to challenging problems and projects, they create an integrated approach to instruction. The focus of instructional time shifts from worksheets and textbook-centered instruction to problem- and project-based learning. Teachers who work together can reinforce in their classes what their colleagues have taught in other classes. *HSTW* studies show that common planning time for teams of academic and vocational teachers is one of the things that matter most in improving student learning. This kind of planning is so important that Making Schools Work has included it as one of the nine key practices for accelerating student achievement.

Good instructional planning requires administrative support.

Teachers need time to make informed decisions about instruction, analyze data, learn new instructional strategies and develop integrated units of study. Administrators can facilitate this process by reducing the number of different class preparations teachers must make. Administrators need to provide teachers with the time they need for developing integrated units and for planning together in subject- or grade-specific teams. Teachers who teach the same course need time to develop common syllabi, standards and end-of-course exams.

Subject-specific vertical teams of high school and middle grades teachers can look for overlaps and gaps in the curriculum and can determine the rigor of standards and quality of student work for each grade level. Such teaming results in curriculum maps and alignment of subject areas.

Teachers need support to transfer what they learn in professional development into their classroom practices. Administrators need to schedule time for teachers to share and reflect on their experiences in implementing new instructional methods.

MSW Key Practices

- Set high expectations and get all students to meet them.
- Get middle grades students to complete an academic core that challenges them to achieve at higher levels and appeals to their interests.
- Get high school students to complete a challenging program of study with an upgraded academic core and a concentration.
- Provide opportunities for all middle grades and high school students to engage in career/technical studies and to use technology in academic courses.
- Provide varied learning activities to help middle grades and high school students link challenging academic content to real-world applications.
- Give all teachers time to work together in planning, developing and conducting high-quality learning experiences and sharing student work that meets standards.
- Base guidance activities on the belief that all students matter and need long-term, personal relationships with adults at the school who will work with them and their parents to set learning goals and make plans for further education and careers.
- Provide a structured system of extra help and quality time that will enable students in the middle grades and high school to complete an accelerated program of study and to meet rigorous and consistent standards.
- Use data on student achievement and school and classroom practices to revise the curriculum and instruction.

Striking a balance

Explicit, direct instruction is clearly a good method for teaching comprehension strategies, procedures for operating equipment, methods of analyzing problems, or basic facts and rules from any content area. For example, direct instruction is the proper, safe strategy for teaching students how to light a Bunsen burner. However, teacher-directed learning should be balanced carefully with student-centered inquiry and discovery learning. Students may become passive and lose motivation if teacher-directed learning is overused. They internalize concepts and relationships when they can apply knowledge and skills to real-life situations.

The challenge for teachers is to balance teacher-directed instruction and student-centered learning, based on examinations of course standards and performance goals as they relate to student needs, skills and interests. A balanced approach requires the teacher to diagnose students' needs, monitor their progress and determine when additional support and instruction are needed to meet course standards.

Most teachers discover that both instructional approaches (teacher-directed and student-centered) are valuable. For example, a teacher may work with students to design a community project that requires them to collect, plot and analyze data. Before the project begins, the teacher decides whether the students have all the skills needed to perform the task. He or she determines whether some students need direct instruction in survey techniques and particular mathematical skills and monitors students' progress throughout the activity, providing support and additional instruction as needed. The following project illustrates the need for both approaches.

Teaching functions in a mathematics class

Teacher-directed component — The teacher gives direct instruction about the notations used to represent functions.

Student-centered component — Students are involved in numerous activities to help them understand which relationships can be represented with functions and which cannot. Students conduct experiments that illustrate functional relationships, bring in real-life scenarios that demonstrate functions and find examples of functions in other courses.

As teachers work to balance teacher-directed and student-centered instruction, they are challenged and invigorated. The balance improves not only learning but also teaching.

Teacher-directed instruction

In a teacher-directed classroom, the teacher plans, shapes and guides the learning process. He or she analyzes course standards and prepares a sequence of instructional strategies to help students acquire the knowledge and skills to meet those standards. The teacher-directed approach provides students with a step-by-step process for tackling complex tasks. It might be called the "straight-line" approach to learning: the shortest, quickest method of spanning the gap between not knowing and knowing. The lecture is an example of teacher-directed instruction.

At its best, teacher-directed learning provides a clear, effective presentation of key concepts and procedures. Teachers structure the classroom environment and learning activities to teach students specific facts or procedures. Teachers model expected behaviors and provide detailed feedback on student progress. Teachers check for understanding by asking questions and encouraging students to think about and react to the information presented. This approach sets clear expectations for student performance and makes the teacher responsible for directing the learning.

Taken to the extreme, teacher-directed instruction can decrease students' motivation to learn. If instruction fails to take into account the students' background knowledge, interests and needs, they likely will lose interest. To connect what is being taught to things with which students are familiar, teachers must have deep knowledge of their subject matter and know their students well.

For teacher-directed instruction to be effective, teachers need to do the following:

- begin a lesson with a short review of prerequisite learning;
- provide a short statement of goals for the lesson;
- present new material in small steps, with student practice after each step;
- give clear, detailed instructions and explanations;
- provide a lot of active practice for all students;
- ask many questions and get answers from all students;
- guide students during initial practice;
- provide systematic feedback and corrections; and
- provide explicit instruction, practice and monitoring for seatwork exercises.

Direct instruction is the best way to teach skills, procedures and processes that are essential components of the curriculum. However, the teacher-directed approach is not just for teaching content-specific information. It also can be used to teach critical-thinking strategies and to evaluate the information students have been given. Instead of allowing students to discover a process for critical thinking, the teacher may instruct them in a step-by-step process, such as the Four-Step Model for Intellectual Skills, developed by Sternberg and Spear-Swerling. (See the list of resources on page 39.) This model balances analytical, creative and practical approaches to problem-solving.

A Four-Step Model for Intellectual Skills

Step 1: Familiarization	***Presentation and interactive solution of real-world problems.*** The teacher presents two or three real-world problems and works with the students to solve them. It is important that the problems be authentic so that students can see the relationship between thinking skills and solutions to real-life problems. The teacher provides the minimal amount of structure needed to help students define and solve the problem. The teacher asks probing questions to help students through the process. ***Group analysis of problem-solving procedures.*** After the students have solved two or three problems, the teacher asks the class to think about and discuss the thinking processes and strategies they used to solve the problems. ***Labeling of thinking processes and strategies.*** The teacher uses the list of processes and strategies identified by the students as the starting point for a lesson. He or she explains that the lesson will deal with some of the strategies and that each process will be labeled to make communication easier. ***Application of labeled processes to new problems.*** The teacher presents two or three new problems. The students apply the labels to help them identify the thinking processes they use to solve problems. ***Student generation of new problems.*** Students generate real-world problems and solve them using the thinking processes and strategies they have identified.
Step 2: Intragroup problem-solving	Members of the class work together to solve a new problem. The teacher observes and encourages students to use the processes and strategies they have learned (as well as others). A student moderator may preside over the discussion. The teacher does not comment on the group's problem-solving process until after a solution is reached.
Step 3: Intergroup problem-solving	Small groups of students develop alternative solutions to the problem. Once the groups have come up with their solutions, they may meet to compare their ideas. Groups also may be assigned a particular position from which to explore an issue.
Step 4: Individual problem-solving	Students solve problems individually. Each student applies the strategies and methods that have been used in the intragroup and intergroup activities.

The Four-Step Model helps students view problem-solving as a process rather than a random event. Teachers guide students in identifying effective strategies and transferring them from one problem to the next. Homework assignments help students identify new problems that reinforce the principles learned in class. In using this model, teachers should begin with real-world problems related to course standards. Problems such as a lack of money or time may stimulate discussion, but broader-based problems also should be used to challenge students.

Student-centered learning

Student-centered learning is based on the belief that active involvement by students increases learning and motivation. Good student-centered learning values the student's role in acquiring knowledge and understanding. Within the context of course standards, this approach empowers students to ask questions, seek answers and attempt to understand the world's complexities. The teacher and students share the responsibility for instruction and assessment. The levels of student involvement may vary. The low end may consist of the teacher's incorporation of student needs, interests, learning styles and abilities. High levels of student involvement may consist of students' playing a role in planning instruction. Regardless of the level of involvement, the basic expectation is that the teacher and students are partners in instruction and learning.

Students who are engaged in the instructional process are more likely to maintain an interest in what they study than are those who are passive recipients of a prescribed curriculum. However, teachers cannot assume that their guidance and support no longer are needed. **While student-centered instruction focuses on the student rather than the teacher, it always is driven by the content standards.** Teachers need to help students identify areas of interest, construct research questions, develop objectives and plan methods of evaluation. Teachers also must consider instructional methods that encourage students to discuss and debate issues, explore problems, generate and test hypotheses, and examine their thinking processes.

Cooperative learning

Collaboration and cooperation are required skills in all walks of life. Although these skills have been recognized as important in the workplace, they frequently are absent from the classroom. Instruction often encourages students to be independent learners, rather than cooperative learners. These students miss the opportunity to learn with and from their peers. **Cooperative learning is an instructional strategy that encourages students to learn together but holds each student accountable for his or her learning.** Students are organized into small groups to solve problems and complete challenging assignments. This approach differs from group work because the assignment and the

individual roles within the group are defined clearly. As students recognize the value of each team member's contribution, collective responsibility develops.

Critics of cooperative learning often insist that the strategy detracts from individual achievement and places the burden of learning on the most capable and hardest-working students, while others slide by without doing an appropriate share of the work. In true cooperative-learning structures, these allegations are unfounded. To ensure that students work as a cooperative team rather than as individuals within a group, teachers can put several conditions in place:

- **Group goals**

Define the group goal clearly so that each group member knows what is needed to accomplish the task. Examples of group goals include creating a team product or becoming an expert on a specific topic.

- **Positive interdependence**

Design the cooperative task so that the group has to rely on the contribution of each member. All team members must participate for the team to succeed. The teacher must define clearly the team roles, such as manager, recorder or presenter.

- **Face-to-face interaction**

Design the cooperative task to promote interaction among students. As students work to meet the group goal, they provide assistance and feedback to team members, exchange information, discuss issues and offer encouragement.

- **Individual accountability/personal responsibility**

Develop a method for assessing the effort and contribution of each member of the team. Each must feel responsible for contributing to the success of the task. Cooperative learning is designed so that the contribution of each team member is essential. No one gets a free ride.

- **Interpersonal and small-group skills**

Require students to work together. Students must know and trust one another, listen to and accept others' ideas and points of view, and develop strategies for dealing constructively with conflicts. Teachers may have to teach students these interpersonal skills before initiating the strategy.

- **Group processing**

Provide time for the team to reflect on the cooperative process. Encourage members to consider the group's strengths and weaknesses and plan improvements. Students need opportunities to provide specific, constructive feedback. Teachers initially may need to provide formal group-evaluation forms to focus students' feedback.

By working to achieve a mutual learning goal, students see themselves as valued contributors to the team. They begin to learn from their peers and to value and respect their own contributions to others' learning. The teacher is no longer the sole purveyor of knowledge and feedback. Students who work in cooperative teams become resources for one another; they provide support, share information and offer feedback and encouragement. Students who are challenged to meet a group learning goal are motivated to help team members. Cooperative learning encourages students to work together, practice skills and discuss problems.

Cooperative activities can meet many objectives. A strategy such as Kagan's Three-Step Interview trains students to examine issues from various perspectives. This strategy begins with the teacher or students posing a question on which the group can easily come to consensus. Students work in groups of four. Each group splits into two pairs of students; in each pair, one student interviews the other. Students then reverse roles, and the interviewer becomes the interviewee. When they return to their groups of four, they share the information learned from their interviews. This strategy enables each student to participate and share ideas. It also requires listening skills: each student has to summarize his or her partner's point of view.

It is essential for teachers to understand and ensure three of the necessary conditions for good cooperative-learning experiences:

1. Communicate to students and parents the purpose of cooperative learning.
2. Establish and explain procedures for grouping and regrouping students.
3. Award individual and group grades.

Refer to the list of resources on page 39 for books on cooperative learning, particularly works by Kagan; Davidson and Worsham; and Johnson, Johnson and Holubec.

During a cooperative activity, the teacher observes students and takes notes on their conversations. The teacher asks probing questions to encourage critical thinking about the task. This process provides the teacher with useful information for planning future cooperative-learning activities.

Project-based learning

Teachers at all levels understand the struggle to make learning meaningful. Students often resist the textbook approach to instruction because they see little, if any, relationship between the text and their lives. Good instructional projects challenge students to solve real-world problems and present their findings. A project-based approach to instruction presents students with problem-focused assignments that are meaningful, interesting and valuable. Planning is the key to this instructional method. Projects not

Before beginning a cooperative-learning experience, a teacher should ask three questions:

1. ***What is the goal of the lesson?*** The answer to this question helps determine the appropriate cooperative-learning structure. For example, if the goal is to help students learn new material, a "jigsaw" activity might be appropriate. In such an activity, the teacher divides the content into segments and assigns each group a different piece to teach the rest of the class.
2. ***How much experience have my students had in this type of cooperative setting?*** This knowledge will determine how much time it will take to "set up" the cooperative activity. It is important that responsibilities and boundaries be well-defined and that students have the social skills necessary to work together. Setting up always takes longer at the beginning of the school year.
3. ***How will I know that the cooperative setting is effective?*** Predetermine the assessment methods for groups and individuals. For example, if students are creating team products to demonstrate their learning for an entire unit, the teacher may have intermediate "checkpoint" assignments for individual students to ensure that all members are contributing. Another example of effective assessment is a checklist that the teacher uses while circulating among the groups and listening as students discuss the key ideas of the assignment.

only reflect student interest but also meet one or more course standards. Unless they are linked to course standards, projects may be interesting and enjoyable but will have little or no effect on academic or technical achievement.

Effective instructional projects have these characteristics:

- They require a question or problem upon which the activities are based. The question may be created by the teacher or by the students.
- Academic objectives are clear.
- The results of the problem cannot be predetermined or solved easily.
- Students have the opportunity to explore the problem.
- Students have sufficient resources and materials for the project.
- Students are involved in the process and know the evaluation criteria from the beginning.

Cooperative learning and the U.S. Constitution

During a study of the U.S. Constitution, a high school social-studies teacher wants students to learn about all of the articles but does not have time for each student to analyze every article deeply. The goal of this lesson is for students to learn the significance of the seven articles of the U.S. Constitution.

With this goal in mind, the teacher forms groups of students and assigns each group a different article to study. At the beginning of the assignment, the teacher familiarizes the students with the schoolwide rubric for presentations. Each group spends several days thoroughly studying and researching the assigned article. The groups present their findings to the entire class.

To include a component of individual accountability, the teacher asks each student to turn in a summary of the group's article. To ensure that they learn from their classmates' presentations, students are assigned different articles at random after the presentations are completed. The teacher asks each student to summarize the randomly assigned article and provide an argument supporting its inclusion in the Constitution.

- Adequate supervision ensures maximum progress but does not intrude and deprive students of the learning experiences associated with the project method.

When students work to solve real-world problems, they must rely on existing and new academic knowledge as well as their ability to apply information, understanding and procedures. Project-based instruction promotes the idea of students as workers by requiring them to focus on a problem and work persistently to solve it. Instead of being passive recipients of academic content, students actively develop and refine questions, debate ideas, make and test predictions, design plans and/or experiments, collect and analyze data, draw conclusions and communicate findings.

The world is filled with problems to be solved. Students need only to examine current events to find stimulating topics:

- controversy over the development of a highway bypass that would relieve congestion but destroy parklands;
- pollution of a local river or lake by a manufacturing firm;
- overcrowding that leads to parking restrictions in the student parking lot;
- runoff from a building site that erodes the adjoining property and washes silt into the neighboring pond; or

- parents' complaints that they do not receive timely information about school programs and events.

Any of these topics raises questions that need to be addressed. Other questions might be developed as part of internship programs, during which teachers or students explore various workplaces. Each question can serve as the basis for a project that inte-

Projects integrate academic and technical skills

Teachers of seventh-grade mathematics and science in an SREB state require their students to complete research projects. They develop guidelines that address selected state standards in mathematics, science and technology.

One team of students wanted to learn how age affects reaction times. The students wondered whether older drivers could stop their cars as quickly as younger drivers do. The students tested the reaction times of people between the ages of 10 and 70. They used the classroom computer to create a spreadsheet to collect and analyze data. Then each student tested five to 10 family members by dropping a ruler into the subject's open hand and noting the space on the ruler at which it was caught. The students brought their data to class, entered the results on the spreadsheet and plotted them on a graph. They noted that the reaction times for people ages 60 to 70 were much longer. As a follow-up to the project, several students wrote a letter to the commissioner of the Department of Motor Vehicles. They suggested that people over age 60 have their reaction times tested before their driver's licenses are renewed.

A high school physics teacher in an SREB state gave her students the following scenario as a lab assignment:

"The principal has decided to shorten the 'passing time' between classes from four to three minutes. Your assignment is to create a factual rationale for not making this change. You may use any of the following in creating your 'white paper': scale drawing of our school, timers, meter sticks and tape measures. Be certain to include the appropriate scientific language for this project, including velocity, displacement and acceleration."

Students collected data on the time required to walk and run between various points of the school. They used physics equations to analyze their results. Each student team was required to prepare a written and an oral report of its results and conclusions. Students evaluated one another, and those with the best reports were invited to present their position papers to the principal and the school board.

grates academic and technical skills. To help students keep the project focused and to ensure that the project meets course standards, goals and objectives, the teacher needs to identify what is expected of students.

When students become involved in the social and political life of the school and community, they can use their knowledge and skills to solve real problems. When students take responsibility for their learning, the burden of motivation is removed from the teacher, who then can be a "guide on the side" instead of the "sage on the stage." This approach encourages students to produce knowledge, rather than reproduce it.

The Socratic Method

Perhaps the oldest method of teacher-directed and student-centered learning is the Socratic method. Derived from Plato's *Socratic Dialogues*, the Socratic method is a time-honored technique in which the teacher asks questions that lead students to examine the validity of a statement. This powerful teaching method engages the learners, stimulates critical thinking and triggers classroom discussions. The method works well when students explore current topics, ethics, social studies, history or literature.

The Socratic method can be adapted to any subject area. All classrooms can become centers for dialogue. Teachers need to plan ways to explore content as it applies to today's social, political and technological world. The Socratic method can be used to involve students in examining contemporary and historical issues. Topics such as immigration, organized labor, school desegregation, religious rights, health care and the conservation of natural resources may be used to engage student interest and stimulate discussions.

The Socratic method is built on a reciprocal relationship between the teacher and the students. Modeling the behavior of Socrates, the teacher asks the students questions that require them to think about their reasoning and their responses. Students who are unaccustomed to this instructional method need to know that the questions are not judgmental but are designed to help them examine their attitudes, beliefs, knowledge and logic.

The greatest challenge is to design thought-provoking questions that will engage students in productive discussions. The teacher portrays himself or herself as a seeker, exploring knowledge with the students. The teacher listens carefully to each response and asks follow-up questions that encourage students to examine and explain their thinking.

When teachers use questions to probe student thinking, they help students process information into meaningful terms and reach a deeper awareness of the issues. The Socratic method values the student's role in determining the meaning of the material studied.

Text: "Mother to Son" (Langston Hughes) Middle School/English/Sociology

Opening question:

The title "Mother to Son" suggests that the mother has something to say to her son. What does she want him to know?

Core questions:

1. What has life been like for the mother?
2. What does the mother's language tell you about her?
3. What does the mother mean by a "crystal stair"?

Closing questions:

1. If you were a parent, what advice would you give your child?
2. What advice have adults in your life given you?
3. What obstacles are on a teenager's "stair"?

In *Socratic Seminars in the Block,* Ball and Brewer outline procedures for using the Socratic method to explore text. They list poems, short stories, essays, novels, sermons/speeches, articles, fables, dramas, art, films and nonfiction texts upon which a Socratic seminar may be based. Newspaper and journal articles that deal with compelling issues also can be the basis for such a seminar. Teachers develop open-ended questions that encourage students to examine the text, express their views and cite textual evidence to support their thinking. **Teachers no longer dispense knowledge as they see fit; instead, knowledge is transferred to the students as they examine issues and ideas.**

The seminar is not an open-ended discussion time during which students can say whatever they want. The teacher directs the discussion by beginning with carefully planned questions that address specific goals. Ball and Brewer provide examples of questions used to stimulate students to think and to process information. These questions challenge students to "read between the lines" and think about the characters, the plot, the author's intent and the relationship between the reading and current issues in society.

For this strategy to be effective, a teacher needs to establish guidelines to help students understand their roles and responsibilities. When conducting such a discussion, the teacher needs to understand what the students should take away from the lesson and always should work toward that goal. The teacher introduces a question and keeps

the discussion moving. Students need to know how to summarize their thoughts, listen to others and offer thoughtful responses rather than emotional reactions. Ball and Brewer offer suggestions for teachers to consider when planning lessons, establishing students' roles and responsibilities and preparing the class for the seminar approach. (See the list of resources on page 39.) It may take students some time to get used to reading for meaning rather than for answers and to reflecting on what they know before responding. Students who develop these skills learn to read, speak and listen more effectively.

Independent research studies

If the goal of education is for students to become independent learners, they need opportunities to take responsibility for their learning. Independent research studies allow students to choose topics related to the subject of study. Students gather, record, evaluate and organize information and draw conclusions based on what they have learned. They use oral and written communication skills to present their findings.

Independent research projects help students develop research skills and understand questions, problems or issues more deeply. The teacher works with the students to plan the projects. When teachers and students work together to design research projects, they need to take several steps to ensure success:

- Define the goals for the projects. What are the desired outcomes?
- Identify what students will do during the projects.
- Consider the skills needed to complete the projects.
- Determine the level of independence required, based on the number and types of decisions that students must make.
- Develop a method for assessing students' learning, including opportunities for them to assess and report on their own performance.
- Set up timelines for the project activities.
- Determine what materials and information students need for the projects and ensure that they have access to the appropriate resources.

Once students have developed the skills for conducting independent research, teacher involvement in designing the projects diminishes. In *How to Create an Independent Research Program*, Krieger stresses the difference between an independent research project and a traditional student report:

Independent research projects are not simple models of the ear or solar system, rock and fossil collections, or reports on the electoral system. Instead, research projects are actual laboratory research projects created by a student or a team of students.

Independent research projects are open-ended. The problems that students pose have no set answers. Teachers help students understand that their original plans or hypotheses may not be successful and that they may encounter many failures before they are successful. (See the list of resources on page 39.)

When students begin to do independent research, they need to appreciate the six steps of the scientific method as necessary components of the investigative process:

1. Define the problem or project.
2. Research the background of the problem or project.
3. Design a procedure or an experiment to carry out the problem or project.
4. Start the procedure or experiment.
5. Analyze the data using statistical methods or the most current and useful research methods.
6. Present the results.

Working together to develop and conduct research projects, students share ideas and discuss findings. They learn to value the contributions of others as well as their own contributions. They realize the importance of their involvement in the learning process. What begins as a research project may become an area of professional interest and a future career.

Student competition is an important part of the research process. One experience that requires students to use research skills is the Duracell Scholarship Competition. Students in grades seven through 12 design and build devices that run on Duracell batteries. Each student who enters the competition must send in a photograph, wiring diagram and written description of the device. The competition establishes the problem and challenges students to solve it.

Reading and writing across the curriculum

Reading and writing are major parts of learning. As information becomes more complex, transmitting it through hour-long lectures or videos becomes increasingly difficult, if not impossible. Therefore, this complex information must be transmitted to learners through some reading process. In addition, complex knowledge ultimately must be assessed through some form of writing. It follows, then, that all teachers are responsible for helping students improve their reading and writing skills. **Reading and writing across the curriculum is an approach to learning in which teachers of all subjects use strategies that promote writing and reading comprehension.** These strategies enable teachers to provide support as students read in textbooks and/or write responses to what they read.

To help students develop reading and writing skills, teachers must think of how to prepare students for the lesson, guide them throughout the lesson and provide them with opportunities to apply what they have learned. All strategies for reading and writing across the curriculum comply with the PAR (prepare, assist, reflect) lesson framework, which is essential to help struggling readers. The PAR lesson framework is built on the premise that teachers must **prepare** students to learn by accessing prior knowledge or presenting necessary background information; **assist** students in the learning process; and help students **reflect** upon what they have learned. Each aspect of the framework is necessary to help students learn effectively.

Prepare — The teacher helps set the stage for reading by drawing upon students' prior knowledge of the content to connect what the students know and the new information. When students lack prior experience, the teacher builds background before introducing new material. The teacher introduces technical or difficult vocabulary during this preparation period. Using text as part of the instructional process establishes a purpose for reading and helps connect the information in the text with students' prior knowledge and understanding. By involving students in a discussion of the topic prior to reading, a teacher learns what students know about the topic, can identify possible misconceptions and can provide a foundation for learning.

Assist — During the reading process, the teacher models comprehension strategies that he or she wants the students to accomplish, asks questions to guide students' reading, and plans activities to help students learn the course content and the related reading, writing and thinking skills. The teacher can use many guided instructional activities, including focused questioning, study guides, graphic organizers and guided notetaking with two-column notes.

Reflect — In this phase the teacher gives students opportunities to think about what they have learned and connect it to their pre-existing ideas or to previous experiences. This phase also allows time for critical thinking and extension of concepts.

Several strategies are associated with reading and writing across the curriculum:

- **Directed reading/thinking activity** — This strategy **prepares** students to comprehend by using predictions about the text they are to read. The teacher guides (**assists**) the students through the selection by asking questions about pictures, titles, subtitles and the like. After the students predict what these elements mean in relation to the text, they are ready to read the text. They already have ideas about what they will read. Once the students have read, the teacher asks them to use the text (**reflect**) to prove the accuracy of their predictions.

- KWL — This strategy is related to the PAR process. The K stands for what students **know** already. The teacher introduces the topic, asks the students what they

know about it and writes responses on the board. The W stands for what the students **want** to know. In this step the teacher asks the students to generate questions about the topic and writes these questions on the board. The L stands for what was **learned.** In this last step, students answer the questions they generated earlier.

- **Anticipation guide/prediction guide** — In this strategy, students react to a list of statements linked to the material they are going to read. This strategy **prepares** students to connect what they already know with information they will learn and provides motivation and interest in the content.

- **GIST** — In this strategy, called Generating Interactions Between Schemata and Text, students are asked to read a one- or two-paragraph passage and summarize it in 20 or fewer words. The students then are asked to read the next paragraph(s) and summarize all they have read (first and second sets) in 20 or fewer words**.** By summarizing more information in the same number of words, students learn to delete unimportant details, select key ideas and use their own words. Students can read the summaries aloud in class and vote on the best one, or a class can work together to make a summary. The strategy seems to work best in cooperative groups.

Anticipation guide for Macbeth

Pre-reading: Place a plus sign in the left column beside the statements you believe are true.

Post-reading: Change any of your first impressions by using the right column.

___1.	There are truly good people and truly bad people.	_____
___2.	You never should kill anyone, even if you will get something in return.	_____
___3.	You never should compromise your values.	_____
___4.	You always should listen to your spouse and do what he/she says to do.	_____
___5.	Someone who uses violence to get power is more likely to fall.	_____
___6.	Witches are real.	_____
___7.	One mistake makes you a failure.	_____
___8.	Greed only leads to bad things.	_____
___9.	The direction of our lives is decided by something's or someone's actions.	_____

Using an anticipation guide in mathematics

A middle school mathematics teacher is beginning a chapter on quadrilaterals. The students have varying knowledge about quadrilaterals and varying interest in mathematics in general. It is a fairly typical seventh-grade classroom. Given the variance in students' knowledge and interest, the teacher decides to use an anticipation guide to do the following:

- discover what students already know;
- create some knowledge of quadrilaterals for those who have none;
- introduce some of the vocabulary found in the chapter; and
- create interest in the topic through discussion and thought.

The teacher hands out this anticipation guide to the students and has each of them decide whether he or she agrees or disagrees with each statement. The teacher assures the students that they will not be graded and will be able to change their answers.

Anticipation guide for quadrilaterals

1. Two quadrilaterals with the same perimeter must have the same area.
2. A rectangle's sides can all be equal in length.
3. Two quadrilaterals with the same area must have the same perimeter.
4. A rhombus' sides can all be equal in length.

Once the students answer the questions independently, the class as a whole discusses them.

Strategies associated with reading and writing across the curriculum are intended to help meet the needs of students who are not reading at grade level and are having difficulty comprehending class materials. However, the strategies help ***all*** students to improve their reading and writing skills.

Likewise, all teachers can use these strategies because reading and writing skills are applied in all content areas. When teachers focus on the basic reading and writing skills needed to understand concepts and to communicate effectively, they strengthen the

skills that make active, independent learners. Regardless of the content area, teachers can incorporate reading strategies. They can develop students' reading and writing vocabularies, guide students as they read and write, and encourage students to respond to what they read. As students develop reading and writing skills, they learn to ask themselves questions, monitor their reading and writing, and organize information.

Several approaches to reading and writing can be adapted to any subject area. A teacher may introduce a new topic by asking students to write down what they know (or think they know) about it. Another strategy is to introduce key vocabulary words and have students define them or predict the meanings. End-of-chapter questions also can serve as the starting point of a lesson by providing students with a guide for what they will learn. The teacher introduces headings from the selection and has students predict what they will learn. Students then read the selections and analyze their predictions in light of what they have learned. Finally, teachers may ask students to think of the importance of what they have learned and to write summaries of their learning.

The importance of reading for information extends beyond classroom assignments. Reading is a life skill that gives students not only information but also pleasure. In order to support lifetime reading habits, teachers always should consider methods that encourage reading. When students are involved in designing instructional projects, they have a vested interest in reading to find information. The teacher also can stimulate an interest in reading by introducing a controversy; students need to read in order to settle points of contradiction and uncertainty. Student interest is a key to getting them to read.

Content-specific strategies

Problem-centered mathematics

A problem-centered approach teaches mathematical reasoning skills. Teachers provide students with opportunities to use objects and pictures of objects to represent mathematical concepts. Instead of teaching students just to memorize mathematical skills and procedures, teachers emphasize the use of these skills and procedures in reasoning through meaningful problems.

The use of problem-centered mathematics extends beyond the word problems found in most mathematics textbooks. Traditional word problems provide practice in mathematical skills but do not promote the types of skills required for solving complex problems. When teachers use the problem-centered approach, skills are not taught in isolation. Instead, the problem is presented first and becomes the focus of instruction. This strategy is good for helping students in middle school and high school to develop a foundation for mathematical problem-solving skills.

The following question establishes a task that interests students and requires them to use reasoning and problem solving. As Erickson (1999) points out, the question is open-ended enough to allow various solution techniques.

Question: To what extent are today's 17-year-olds like their ancestors?

Small groups of students could tackle this problem in a statistics unit that includes averages, measures of dispersion, lines of best fit and chi-square tests or t-tests. Students generate more specific questions, collect data and use statistical methods to produce possible models and reasonable conjectures or answers to the questions. They present their findings in writing or in presentations that reflect the mathematics they have learned. Some of the questions they generate may be the following:

- How do the physical characteristics (such as height) of a student compare with those of his or her parents or grandparents?
- In what hobbies or school subjects did the student's parents or grandparents engage when they were a comparable age?
- How many children were in each generation of the family?
- What is the relationship between the ancestors' years of education and their incomes?
- How satisfied with their jobs were members of different generations of the family?

(See the list of resources on page 39.)

Mathematics textbooks traditionally approach problem solving in a way that has been criticized as overly mechanical. When students focus on mechanics without understanding the process or complexities of the problem, it is unlikely that they will be able to use what they learn in the classroom to solve other realistic problems. By involving students in interesting problems, teachers can promote the idea that mathematics is a dynamic subject. Students begin to see that they are part of the learning process as they gather, discover and create knowledge while solving meaningful problems.

The key to this strategy is finding "good" problems, many of which can be found in the school and in the community. Teachers and students do not need to look far to find interesting problems that require reasoning and mathematical skills.

"Good" problems have the following four characteristics:

1. The solution involves the understanding of a mathematical concept or the use of a mathematical skill.

2. The problem can be extended.

3. The problem can be solved in several ways.

4. The problem interests students.

The following are examples of "good" problems for middle grades students:

- Which brand of tennis shoes do students prefer?
- How might we landscape the school's garden to make it cost-effective, attractive and easy to maintain?

For high school students, the following might be "good" problems:

- Given several characteristics of cities (crime rate, population growth rate, school rankings), how might we decide which city is most livable?
- How can we use what we know about exponential decay to determine the dosage of medication that will allow patients to take a drug only twice a day?

In a traditional mathematics classroom, the routine begins with checking the previous night's homework. Then the teacher demonstrates how to do exercises using a new method, and students practice that method. In a problem-centered mathematics classroom, the teacher takes an approach similar to the one below:

Pose a problem. This problem exhibits the characteristics of a "good" problem. (See description above.)

Have students struggle with the problem. Students address the problem on their own or in groups, depending upon the problem. During this time, the teacher does not interact too much with the students; he or she gives them time to reason through the situation on their own. This activity gives students a vested interest in solving the problem.

Have students present possible solutions. Students share proposed solutions with the entire class or with others in their subgroups.

Have students discuss the solutions. This step also involves either the entire class or subgroups. The teacher synthesizes students' ideas, clarifies ideas and adds any missing pieces of information.

Assign homework that focuses on the key ideas from the day's lesson. Compared with traditional homework assignments, these assignments have fewer problems, but those problems all meet the standards for "good" problems. The homework may include mathematical situations that serve as a prelude to the next day's lesson.

Problem-centered mathematics classrooms focus on teaching skills and procedures, understanding and reasoning. Students see mathematics as a tool for solving problems instead of as a set of distinct, fragmented skills. Teachers who incorporate the following research-proven strategies into their classroom practices promote student understanding and higher achievement:

- Emphasize the mathematical meanings of ideas. Show logically and consistently how an idea, concept or skill is connected to other mathematical ideas.
- Create a context for learning in which students can construct meaning. Connect new ideas and concepts with students' prior knowledge and experiences.
- Clearly connect mathematics with other subject areas.
- Recognize individual students' approaches to learning and understanding.

Teaching linear relationships through archaeology

One of the most important concepts in middle grades mathematics is that of linear relationships. Students who master this concept perform better in high school mathematics. A problem-centered mathematics lesson on linear relationships can begin with an archaeological scenario:

A recent archaeological dig uncovered a thigh bone of someone buried thousands of years ago. Archaeologists are interested in finding out the person's height, because this knowledge helps them understand the lifestyles and nutritional patterns of the past.

Pose a problem. What kind of relationship might exist between the length of your thigh and your height?

Have students struggle with the problem. In groups of three or four, students measure their height and the length of their thighs looking for a possible relationship.

Have students present possible solutions. The groups present their analyses to the class. The class discusses the solutions.

Synthesize students' ideas and add more content as necessary. The teacher helps the class organize the information to see whether there is a linear relationship evident in the table of data. The class graphs the data and looks for a visual pattern in the graph.

Assign homework that focuses on the key ideas from the day's lesson. The students' homework assignment is to predict a mummy's height, given the length of its thigh. Students also measure the thigh lengths of two or three family members and bring their findings to class. They also find other linear relationships at home and bring two examples the following day. This homework is an introduction to developing linear equations.

Inquiry-based science

If students are to develop scientific literacy, they must do more than learn scientific facts, memorize procedures and respond to textbook questions. Scientific literacy focuses on developing the skills and understanding that apply in the world outside the classroom and laboratory. In order to build understanding, students must explore scientific content in the context of real-world problems; examine and discuss science's impact on society, both present and past; and learn how scientists reason.

As teachers design strategies to help students identify scientific concepts, it is important to consider what perceptions students bring to the classroom. If teachers are familiar with what students already know, they can build bridges between the known and the unknown. They also can clarify misconceptions in order to help students comprehend new information. To understand scientific concepts, students must be able to explain scientific phenomena in their own words rather than simply repeat parts of the textbook. By asking probing questions and challenging students' understanding, teachers can encourage students to make meaning of scientific phenomena.

Inquiry-based science instruction focuses on making meaning. Instead of relying exclusively on the teacher or the textbook for information, students find their own answers to questions. Using the scientific inquiry process, students develop problems, formulate hypotheses, design and carry out experiments, gather and analyze data, and draw conclusions.

Teachers in inquiry-based classrooms act as facilitators and resources rather than directors. They create situations that grab students' attention and draw them into scientific investigations. Teachers create the environment for investigations that require students to apply conceptual knowledge, mathematical and technical tools, and scientific process skills. Teachers select learning experiences and adapt or design curricula to meet students' interests, knowledge, abilities and backgrounds.

An inquiry lesson consists of seven basic components:

- **The problem** — Pose a problem that is real, meaningful to the students and suitable for study.
- **Background information** — Provide the information that students need to have a common level of understanding. Share information through brief class discussions, readings or preliminary experiments.
- **Materials and resources** — Give students access to adequate materials and resources.

- **Guiding questions** — Develop a list of questions to direct students' thinking as they attempt to solve the problem.
- **The hypothesis** — Promote discussions and ask questions to help students formulate the hypothesis.
- **Gathering and analysis of data** — Conduct experiments to test the hypothesis. Emphasize record-keeping and a systematic approach to data collection.
- **Conclusion** — Base the assessment of the activity on oral and written reports and discussions.

Guided inquiry-based instruction combines the processes of scientific investigation to promote positive attitudes toward learning. Students are encouraged to approach the unknown with a sense of exploration and with methods for solving problems. They become investigators who rely on their knowledge and skills to solve complex problems. Teachers plan experiences that stimulate students' interest and provide them with opportunities to use investigative skills in exploring scientific concepts.

Events that cause students to ask "How did that happen?" can be used to stimulate inquiry. These events make students want to examine what they see in light of what they know. When students find a discrepancy, they have a reason to explore the problem. Classroom demonstrations or reading assignments also can stimulate inquiry.

Using the scientific method as a guide, students form and test hypotheses through observation and inference; they collect and analyze results and develop conclusions based on data. The scientific method is the essential framework of the lesson, not the lesson itself. It is the vehicle through which students learn the concepts and engage in their own learning.

Dispelling the myths about gravity

In one SREB state, a seventh-grade physical science lesson about gravitational force used an inquiry-based instructional strategy. The teacher began the lesson by asking students about their observations of falling objects. The teacher encouraged a discussion, which included the misconception that heavy things fall faster. Students then investigated the rates at which heavy and light objects fall by dropping steel balls, wooden blocks, tissue paper and feathers. Using the appropriate materials and equipment, students made predictions (hypotheses) and then tested their ideas (experiments). A summary of the students' results enabled the teacher to make sure that the concept was developed, the misconceptions were resolved and the students could restate the concept in their own words.

INTEGRATED LEARNING

A good school is committed to improving the intellectual quality of education and preparing students for further education in schools or in the workplace. A quality education in the middle grades or high school equips students to think analytically, to reason, to judge and to balance opposing points of view. Integrated learning encourages students to use their academic and technical knowledge to solve problems typical of those in the school, community, home or workplace. It allows students to construct new meanings and understandings from information and ideas. Integrated learning shows students how all learning fits together.

Integrated learning enables students to test their knowledge by solving problems, building products, and giving performances or writing reports that synthesize their ideas. Integrated learning occurs when teachers link their disciplines and teach content and skills in a broader context. Students see meaning and purpose in their studies when they do the following:

- complete hands-on projects that are valuable to them and to their peers;
- set goals and establish performance standards tied to course standards;
- plan projects and assess their work; and
- critique projects, challenge assumptions, analyze problems and issues, and find solutions.

A school with a strong integrated-learning culture has the following characteristics:

1. School staff share a clear vision for high-quality, intellectual work and receive strong support from school and district leaders.
2. A challenging curriculum includes the high-level mathematics, science, communication and technical skills that are required by an increasingly complex society.

Integrating environmental concepts in a field day

Wirt County Middle School in West Virginia — in cooperation with the U.S. Department of Agriculture, the West Virginia Soil Conservation Service, the County Commission and the Development Authority — held a Wetland Field Day to highlight the environmental curriculum. Students worked together on 20 acres of land to learn about aquatics, soils, wildlife, forestry, geology, wildflower identification, entomology, water testing and watershed management. Students carried out various experiments and wrote about and presented their findings.

3. Rigorous exploratory and technical courses require students to reason, solve problems, plan, conduct research, and organize and present information.

4. Instructional strategies engage students in developing thorough understandings of topics; manipulating information and ideas; and using real problems, issues and projects that have value outside the classroom.

5. Clear assessment standards require students to use their knowledge and skills in new and challenging ways.

6. The organizational structure allows teachers to plan and work together to push students to excel.

7. Parent and community involvement helps connect the school and the "real world" and builds support for high performance by all students.

Administrators and teacher leaders can take 10 steps to begin integrating course content and skills across the curriculum:

Step 1. Support teachers in learning to work in interdisciplinary teams. While interdisciplinary teams often are found in the middle grades, high school teachers generally work in intellectual, physical and emotional isolation. Teachers at all levels rarely connect with one another to plan curricula or discuss teaching strategies. To help teachers work together, administrators can take several actions:

- establish a goal of higher student achievement;
- agree with teachers on the principles of effective teaching and learning;
- create a school schedule that gives teachers time to plan together and to learn from one another;
- build trust and confidence between and among teachers and administrators;
- participate in and provide sustained schoolwide staff development in creating integrated academic and technical lessons, units and projects; and
- explain to parents and the community about integrated learning and the use of the community as a classroom.

Step 2. Establish a mission that will guide the development of integrated learning schoolwide. A mission statement reflects what a school is. For example, the mission of the middle grades is to prepare students to take college-preparatory courses in high school; the mission of the high school is to prepare students to enter postsecondary study without having to take remedial courses and to enter the workplace.

Step 3. Create a vision of school and classroom conditions that will improve learning for all students. These conditions are based on the Making Schools Work key practices that are the foundation for raising student achievement.

Step 4. Review all available data (MSW Assessment results; retention, dropout and graduation rates; state and local assessment results; SAT/ACT scores; percentages of students who have to take remedial courses in ninth grade and in college; state report cards; scores on employer examinations) to get an idea of the current state of student achievement. What content are students taught? What instructional methods are used? Is a student doing poorly in all classes or in a few? How do students connect content from one class with content from other classes and with the real world?

Step 5. Support teachers in learning as much as possible about integrating technical and academic education. Send teachers to workshops and conferences, buy books on integrated learning, allow teachers to visit schools with good integrated activities, and have teachers visit one another's classrooms.

Step 6. Ask all middle grades teachers to identify eight to 10 "big understandings" that their students will need for success in rigorous high school studies. Ask all high school teachers to list the "big understandings" that their students need for success in postsecondary education or careers. Teachers need to review their own course standards, student performance standards, and national, state and district core competencies. Teachers can interview representatives from businesses and colleges to see what they expect of graduates. Teachers also can survey parents to see whether they are satisfied with the education their children are receiving. These discussions will help teachers develop lists of academic and technical concepts on which integrated units and projects can be based.

Step 7. Ask teams of academic and technical teachers to connect these "big understandings" from their disciplines with those from other disciplines. This step is critical in integrated learning because teachers begin to see the significant concepts that they have in common. This review is followed by curriculum-mapping — a process in which teachers review their curricula, list the content and skills that are taught each week, and compare what they are teaching with what their peers are teaching. The mapping not only eliminates redundancy but also helps teachers to link concepts and skills across the curriculum and to create combined projects with teachers of other subjects.

Step 8. Select an integration approach. The following are some typical approaches:

- **Single-course integration** — Teachers integrate academic and technical skills and knowledge from other curriculum areas into their courses.

- **Joint planning across or within departments** — Teachers work together to select academic or technical concepts and skills to stress in their classes so that students see connections across the curriculum.

- **Interdisciplinary approaches** — Several teachers work together to plan learning activities with common objectives. There are several approaches to this method:

  1. **Team teaching** — Two or three teachers align their curricula and develop collaborative plans to use authentic problems, issues and processes to teach related content and skills.

  2. **Short- or long-term projects** — Students complete projects in which they apply academic ideas, perspectives, inquiry methods and research. They complete projects on their own or in groups and usually receive grades in more than one class.

  3. **Thematic projects** — Students complete complex projects, such as building a house or solar car. These projects can involve several departments — even the entire school.

  4. **Thematic units** — Teachers identify a broad theme that connects and reinforces several academic and technical concepts. Thematic units are more flexible than thematic projects because teachers and students can pursue many challenging assignments linked to the theme. Thematic units often involve community issues.

  5. **Academies** — Academies are schools-within-schools that comprise small groups of students who study broad concentrations, such as business and finance, pre-engineering, or health and human services. Integrated learning occurs when academic and career/technical teachers work with the same groups of students.

Step 9. Develop an integrated-learning plan to address the "big understandings." Have teachers describe a project, research question or thematic topic that helps students begin the integration process. Base the instructional activity on a challenging project or question that incorporates academic knowledge, technical understanding and inquiry methods. The project will demonstrate whether students have learned the essential academic and technical content and skills that connect to the "big understandings."

Step 10. Review and improve integrated activities. As integrated learning becomes the norm for students, the projects will become more complex. Revision and refinement are vital for both students and teachers.

Team teaching

Team teaching at Swain County High School in North Carolina began with a specific need. Students who doubted they could succeed in advanced science courses were avoiding the health occupations curriculum. Joan Thomas, a health occupations teacher, and Janet Clapsaddle, a science teacher, worked together to change students' perceptions.

With strong administrative support, the teachers used a shared planning period and many lunch periods to create and align a new curriculum that combined biology and chemistry with health occupations. They considered the similarities in the courses and the ways that hands-on experiences could show students how the content could be applied in the real world. The two teachers' support for each other was vital to the project's success. "It's important to agree in advance on such things as classroom rules, as well as which teacher is going to do what," Clapsaddle said. The principal and the vocational director arranged for substitute teachers and provided financing when Clapsaddle and Thomas needed time away from school to participate in professional development. The guidance department made sure the new class schedule would work. Thomas, who now is retired, said, "It was the most exciting point in my career."

The two teachers developed and began teaching together an applied biology/chemistry course — scheduled back-to-back with the introductory course to health occupations. Health occupations students have access to laboratory facilities, and the applied biology/chemistry course has a much-needed focus. No longer a survey course, it is now an intensive study of anatomy and physiology. Students develop confidence in their ability to learn science and begin connecting science with future careers. Students earn separate credit for each course, even though some test grades count in both courses. Assessment emphasizes projects and presentations, however, rather than conventional tests. The back-to-back scheduling provides students with extra time to set up and follow through on lab experiments. "I like having a two-hour class," one student said. "We get involved in what we're studying."

The course, which has been taught for eight years, continues to challenge and interest students. Data for the 1999-2000 school year show that 67 percent of students in the class successfully completed chemistry and 60 percent took at least one science course above the three required for graduation. While Thomas has retired and Clapsaddle is now the assistant principal at Swain County High School, Debbie Parsons and Peter Julius have taken over and work as a team to get students interested in the health professions and convince them that they can learn science.

Using technology in the classroom

Integrating technology into instruction provides students with fresh ways to learn and opportunities to apply knowledge to new situations, thereby encouraging problem-solving and thinking skills. As teachers develop instructional plans, they need to make sure that students have access to technology that enhances learning.

Students need to learn to use technology in conducting research and in presenting what they have learned. The International Society for Technology in Education has devised performance indicators for grades six through 12. These indicators will help administrators and teachers develop student competencies.

By the end of eighth grade, students will be able to accomplish the following:

- identify and solve routine problems with hardware and software;
- demonstrate knowledge of changes in information technology and the effects those changes have on the workplace and society;
- behave legally and ethically when using information and technology and discuss the consequences of misuse;
- use content-specific tools, software and simulations (such as environmental probes, graphing calculators, and Web tools) to support learning and research;
- apply productivity/multimedia products to support personal productivity, group collaboration and learning throughout the curriculum;
- use technology to design, develop, publish and present products (such as Web pages and videotapes) related to classroom content;
- select and use the appropriate tools and technology to accomplish various tasks and solve problems;
- demonstrate an understanding of the concepts behind hardware, software and connectivity as well as an understanding of their practical applications in learning and problem-solving; and
- research and evaluate the accuracy, relevance, appropriateness, comprehensiveness and bias of electronic information sources.

By the end of grade 12, students will be able to accomplish the following:

- identify the capabilities and limitations of technology resources and assess the potential of these systems and services to address workplace needs and personal, lifelong learning;

- make informed choices among technology systems, resources and services;
- analyze the advantages and disadvantages of widespread use of and reliance on technology in the workplace and in society;
- demonstrate and advocate (among peers, family and the community) the legal and ethical use of technology and information;
- use technology to manage and communicate personal/professional information (such as finances, schedules, addresses, purchases and correspondence);
- evaluate technology-based options for lifelong learning, including distance education;
- routinely and efficiently use online information resources to meet needs for collaboration, research, publications, communication and productivity; and
- select and apply technology tools for research, information analysis, problem-solving and decision-making in content areas;

Teachers have a multitude of technological resources, but technology alone does not guarantee improved student learning. ***Technology is a powerful tool only if it is used effectively.*** Listed below are some tips for using technology to engage student learning. To use these techniques, teachers need access to the technology, skills in using the technology and time to plan ways to incorporate the technology into their lessons.

Tips for using technology to engage student learning

1. Don't abandon successful lesson plans. Integrate technology into these plans when appropriate. For example, encourage student writing with Web sites for student publications (www.worldkids.net, www.academicpress.com) and student e-mail pen-pal sites (www.nerd.world.com).
2. Incorporate spreadsheets, databases, word processors, graphing calculators, presentation software and other technology into the instructional programs of all content areas. Demonstrate how to use the technology and give students opportunities to use it.
3. Use computer activities to reinforce instruction. Computer work can provide students with additional learning opportunities. There are many resources available through the U.S. Department of Education (http://thegateway.org).
4. Take "virtual field trips" to historical sites, art galleries, museums or other interesting places worldwide. Make students responsible for designing the trips.
5. Use computer simulations to explore real-world problems.

6. Expose students to the use of technology in businesses and industries by visiting local businesses and inviting business leaders to discuss technology's role in the workplace.

7. Give students some of the responsibility for designing class or school Web pages.

8. Have students use communication technology to explore problems and discuss issues with other students and with experts in the field.

9. Make sure all students have access to technology. Make computer labs available before school, during lunch and after school.

10. Use Web resources to deliver content. Brainium.com (www.brainium.com) is a global provider of online educational content for students in kindergarten through eighth grade. Students read, interact and learn through animation, adventures, games, experiments and lessons.

11. Use teacher productivity applications for tasks such as making overheads, grading student work and sending notes home to parents. Some useful sites are www.bullwhip.com, www.pageone.lightspan.com, www.thinkwave.com, www.mygradebook.com and www.teachervision.com.

12. Get ideas for lesson plans from Internet resources. Some sites that offer standards-based lesson plans, assessments and scoring guides are http://encarta.msn.com and www.chem4kids.com.

13. Have students use the Internet to do research projects. Some good research sites are www.libweb.sdsu.edu, www.lib.virginia.edu and www.cln.org.

14. Plan a Technology Night for parents and the community. Have the students be "the teachers" — planning, presenting and evaluating the activities.

15. Invite an e-business or other technology group to be your classroom's business partner. Encourage your partner to visit the classroom and discuss technology with the students.

16. Invite your principal or technology personnel from the central office into your classroom to help celebrate students' accomplishments in the use of technology.

17. Use e-mail to communicate with parents. If your school doesn't provide access, set up your own free account with a service such as Hotmail (www.hotmail.com).

Classroom management

As teachers explore various instructional practices that balance teacher-directed and student-centered approaches, they must consider how these learning activities may affect classroom management. Teachers must manage the many interactions that occur in the classroom in order to use instructional time efficiently. Well-managed classrooms are organized to support the learning environment. Managing a classroom is much more than maintaining discipline; it is a complex task that involves the interaction of teachers and students and the organization of materials and space. As Doyle points out, "Classroom management is fundamentally a process of solving the problem of ***order*** in classrooms rather than the problems of misbehavior or student engagement." (See the list of resources on page 39.) Skilled teachers realize the importance of planning for instruction and organizing the classroom to support instruction.

The following tips highlight key considerations for teachers who plan and orchestrate many daily events and interactions in the classroom.

Classroom management tips

- Establish rules and procedures that are concrete, explicit and functional.
- Realize that rules and procedures should be consistent but may be adapted to fit a particular activity. Communicate expectations for academic performance and behavior to students.
- Demonstrate and rehearse procedures and activities so they become part of a routine. If new instructional strategies are used or if students are given more responsibilities, make sure there is time to demonstrate and rehearse the procedures.
- Monitor and enforce the rules and procedures that are established. Let students know how the monitoring process will work. Focus on getting students to meet course standards and goals rather than on correcting misbehavior. Develop rules that help students perform appropriately.
- Anticipate possible interruptions or problems and be ready to handle them.
- Be proactive rather than reactive. Take time to think through the lesson or activity in order to anticipate problems and prepare procedures.
- When monitoring student behavior in cooperative groups, in classroom discussions or during independent projects, tell students how they should behave for that situation. Communicate high expectations for involvement and successful completion of the task.
- Be aware of what goes on in the classroom.

- Participate actively in all classroom activities. Monitor students as they work on projects, solve problems and discuss issues. Ask questions that require students to explain what they are doing and learning.
- Organize and pace instruction to maintain student interest and attention.
- Plan lessons that balance teacher-directed and student-centered activities. Establish timelines for student projects. Have checkpoints throughout the projects to monitor understanding and to maintain a project schedule.
- Establish routines for transitional periods (beginning and end of the class period and between activities).
- Plan procedures for the times that students will move from one activity to another. Be ready to answer the question "What do I do next?" Focus on maximizing instructional time.
- Arrange instructional materials and supplies for easy access. Organize the room to permit orderly movement and to support the instructional goals.
- Design a classroom that will support various instructional strategies, including those that require individual work and group work.

Classes should be businesslike in the attention that is given to the lesson, but they also should be conducive to active learning. The suggestions below may prove helpful; however, remember that student-centered instruction is noisy!

1. **Organization** — Develop positive rules and serve as an exceptional role model. Help students view school as a work environment in which they are responsible for their own effort.
    - Consider arranging the seats in a U-shape or in small clusters so that you can move around easily and students can work with one another.
    - Establish simple routines for collecting homework, tests and other materials.
    - Give clear, simple instructions for every activity.
    - Have an activity for students to do as soon as they enter the classroom.
    - Do not do work for students that they can do themselves.
    - Require all students to have the necessary materials (books, paper, pencils) every day.
2. **Speaking with students** — Treat them as professionals.
    - Talk directly to students to show respect and courtesy.
    - Take responsibility for your words and actions and ask students to do the same.

- Make statements rather than ask questions that make students become defensive.
- Talk ***with*** — not ***at*** — students.

3. **Listening to students** — Treat them as professionals.
   - Never belittle a student's contribution to the group.
   - Do not evaluate when listening.
   - Do not respond before the student has finished speaking.
   - Encourage students to reflect before speaking.
   - Make eye contact; watch nonverbal responses!
   - Give encouraging responses, such as nodding and smiling.
4. **Classroom misbehavior** — Determine the real reason for the misbehavior.
   - Be selective in punishing students for misbehavior. Sometimes a student is bored or simply wants attention. Try to involve the student in another activity or ask the student to explain an idea or concept.
   - Decide what is really "bad" behavior. Don't punish students for everything!
   - Keep a sense of humor. Sometimes students are trying to be funny, not bad.
   - React calmly to disruptive behavior. Students like to "push buttons."
   - Make the consequences for misbehavior consistent.
   - Let students know they are responsible for their behavior.
5. **Instructional strategies** — The more student-centered that instructional strategies are, the less likely students are to cause disruptions.
   - Involve students in making decisions about projects, papers and other activities.
   - Help students organize and understand their work. When instructions are unclear or students feel uneasy about what is required, they often misbehave to mask their feelings of inadequacy.
   - Get students to participate actively. Make each student responsible for his or her success and for the group's success.
   - Ask a question; then give students time to think before calling on someone.
   - Relate the lesson to the students' world whenever possible.
   - Use cooperative groups, competition among groups and role-playing to help students develop personal attachments to the activity.

- Use high-level learning strategies that cause students to think before they act.
- Have students evaluate their work and that of their peers.

6. **Getting students to work beyond normal limits** — Have higher expectations.
   - Let students know what "good" work looks like.
   - Require projects that involve academic skills and the world outside the classroom.
   - Ask students to do a lot of reading, writing and analyzing in all classes.
   - Don't provide students with answers; let them figure out the answers.
   - Treat students each day as if they have a new chance to succeed. Downplay past problems or poor work.
   - Reward effort.

Summary

Teachers and students have choices in how they teach and learn. Teachers who use various strategies are more capable of motivating and exciting students. They make learning relevant, fun and challenging. Good teachers know that students who are involved in an engaging program of study are more likely to succeed. These teachers also know that students learn more when they are actively involved in and are responsible for their own learning. Flexibility in teaching makes learning more creative and more rewarding — for teachers and for students.

For creative, relevant and challenging learning to take place, teachers need time to plan effective lessons and to tie instructional activities and assessment to course standards. The planning process is strengthened when teachers work together to examine students' work, to create integrated units of study, and to share ideas and teaching strategies.

By using various instructional strategies, teachers provide different ways for students to address their goals and to meet higher expectations. Good teaching instills in students the desire to learn and to reach beyond their grasp. Benjamin Mays, the well-known Atlanta educator, said: "It must be borne in mind that the tragedy in life doesn't lie in not reaching your goal. The tragedy lies in having no goal to reach. It isn't a calamity to die with dreams unfulfilled, but it is a calamity not to dream. ... It is not a disgrace not to reach the stars, but it is a disgrace to have no stars to reach for. Not failure, but low aim, is sin."

This, then, is the underlying purpose of this guide: to help teachers deepen students' learning and to challenge teachers and students to set learning goals that go far beyond the classroom.

Resource list

This resource list is provided to help the reader access the works referred to in the text. Web addresses also have been included to facilitate this access.

Ball, W.H., and P. Brewer. 2000. *Socratic Seminars in the Block.* Larchmont, N.Y.: Eye on Education. (www.eyeoneducation.com)

Davidson, N., and T. Worsham. 1992. *Enhancing Thinking Through Cooperative Learning.* New York: Teachers College Press.

Doyle, W. 1986. Classroom organization and management. In *The Handbook of Research and Teaching,* 3rd ed., ed. M.C. Wittrock. New York: MacMillan Publishing, (www.amazon.com)

Erickson, D.K. 1999. A problem-based approach to mathematics instruction. *Mathematics Teacher,* 92(6): 516-21. (www.nctm.org)

Johnson, D.W., R.T. Johnson and E.J. Holubec. 1994. *Cooperative Learning in the Classroom.* Alexandria, Va.: Association for Supervision and Curriculum Development. (www.amazon.com)

Kagan, S. 1994. *Cooperative Learning.* San Clemente, Calif.: Kagan Cooperative Learning. (www.kagancooplearn.com)

Krieger, M.J. 1999. *How to Create an Independent Research Program.* Alexandria, Va.: Association for Supervision and Curriculum Development. (www.ascd.org)

Sternberg, R.J. and L. Spear-Swerling. 1996. *Teaching for Thinking.* Washington, D.C.: American Psychological Association. (www.amazon.com)

Resources for problem-centered mathematics

The following four books are available at www.nctm.org:

- *Principles and Standards for School Mathematics,* by the National Council of Teachers of Mathematics;
- *Developing Mathematical Reasoning in Grades K-12,* edited by Stiff;
- *The Teaching Gap,* by Stigler and Hiebert;
- *A Core Curriculum: Making Mathematics Count for Everyone,* by Meiring.

The following Web sites also may be helpful:

www.enc.org

http://illuminations.nctm.org

http://math.rice.edu/~lanius/Lessons/

http://cord.org/workplacelibrary/indices/student.html

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U.S. Department of Education
Office of Educational Research and Improvement (OERI)
National Library of Education (NLE)
Educational Resources Information Center (ERIC)

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